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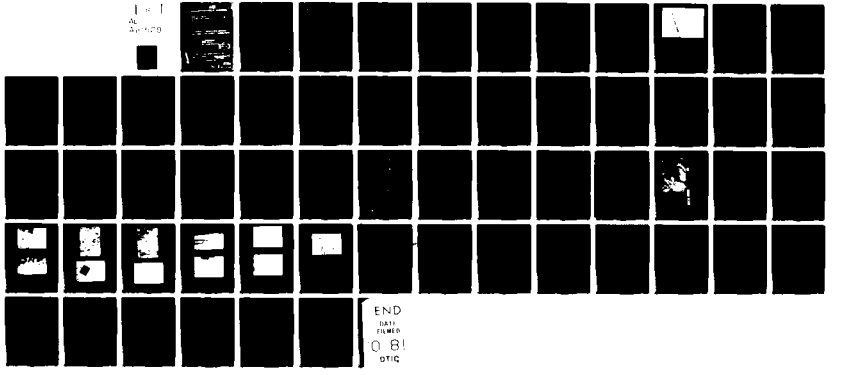

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Upper Valle Mines Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Upper Valle Mines Dam (MO 30370).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

For Phase I reports, the extent of the downstream damage zone has been determined assuming that all materials contained by the tailings dam are in a liquid state.

SUBMITTED BY: SIGNED
Chief, Engineering Division
4 FEB 1981
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer
5 FEB 1981
Date

UPPER VALLE MINES DAM

Jefferson County, Missouri

Missouri Inventory No. 30370

Phase I Inspection Report

National Dam Safety Program

Prepared by

Woodward-Clyde Consultants

Chicago, Illinois

Under Direction of

St Louis District, Corps of Engineers

for

Governor of Missouri

December 1980

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I investigation is not to provide a complete evaluation of the safety of the structure nor to provide a guarantee on its future integrity. Rather the purpose of the program is to identify potentially hazardous conditions to the extent they can be identified by a visual examination. The assessment of the general condition of the dam is based upon available data (if any) and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies. In view of the limited nature of the Phase I studies no assurance can be given that all deficiencies have been identified.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with any data which may be available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action removes the normal load on the structure, as well as the reservoir head along with seepage pressures, and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, so that corrective action can be taken. Likewise continued care and maintenance are necessary to minimize the possibility of development of unsafe conditions.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Upper Valle Mines Dam
State Located	Missouri
County Located	Jefferson
Stream	Unnamed Tributary of Joachim Creek
Date of Inspection	15 August 1980

Upper Valle Mines Dam, Missouri Inventory Number 30370, was inspected by Richard Berggreen (engineering geologist), Leonard Krazynski (geotechnical engineer), and Sean Tseng (hydrologist).

The dam inspection was made following the guidelines presented in the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession. They are intended to provide for an expeditious identification, based on available data and a visual inspection, of those dams which may pose hazards to human life or property. In view of the limited nature of the study, no assurance can be given that all deficiencies have been identified.

Upper Valle Mines Dam is an abandoned tailings dam and is classified as small based on its 38 ft height and storage capacity of 145 ac-ft. The small size classification applies to dams between 25 and 40 ft height or with storage capacity between 50 and 1000 ac-ft.

The St Louis District, Corps of Engineers, has classified this dam as having a high hazard potential; we concur with this classification. The estimated damage zone length extends approximately 7 miles downstream of the dam. Within the first 2 miles are numerous (15 to 20) vacation dwellings in the community of Valle Lake, and two dams, Lower Valle Mines Dam (MO 30439) and Lake Valle Dam (MO 30438). Other scattered dwellings occur throughout the estimated damage zone. The loss of life and property could be high in the event of dam failure.

The visual inspection and evaluation of available information indicate the dam is in generally poor condition. This judgment is based on the inability of the spillway to pass the 1 percent probability-of-occurrence (100 year) flood without overtopping the

embankment, the hazard of erosion posed to the embankment in the event of overtopping, the dense vegetation on the embankment, as well as the steep slopes and evidence of limited past slumping on the downstream face of the dam.. The lack of periodic inspections and maintenance of the dam and spillway is also considered a deficiency.

Hydraulic and hydrologic analyses indicate the spillway is not capable of passing the one percent probability-of-occurrence event without overtopping the embankment. The dam will not be overtopped by the 10 percent probability-of-occurrence event. All floods in excess of 10 percent of the Probable Maximum Flood (PMF) will overtop the dam. The 50 percent and 100 percent PMF will result in overtopping the embankment by approximately 0.8 ft and 1.2 ft, respectively. The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for Upper Valle Mines Dam, which is classified a small size dam, is specified to be a minimum of one-half the Probable Maximum Flood. Considering the large number of dwellings within 2 miles downstream, evidence of past slumping of the downstream slope, and the fact the earth materials comprising this dam are highly erodible in the event of overtopping, 100 percent PMF is, in our opinion, the appropriate spillway design flood.

Based on our inspection of Upper Valle Mines Dam, it is recommended that further study be conducted and remedial measures taken without undue delay to:

1. Increase the height of the dam and/or the capacity of the spillway to safely pass 100 percent of the PMF without overtopping.

The following items should be investigated and the appropriate action taken as soon as practical:

2. Removal of large trees and control of detrimental vegetation on the embankment. This study should also include methods of controlling vegetation in the spillway and discharge channel. Removal of large trees should be done under the guidance of an engineer experienced in the design and construction of dams. Indiscriminate clearing may jeopardize the safety of the dam.

3. Performance of seepage and stability analyses of the dam comparable to those required in the "Recommended Guidelines for Safety Inspection of Dams".

4. Evaluation of the practicality of a warning system for alerting downstream residents, should unsafe emergency conditions develop at the dam.

All remedial measures should be conducted under the guidance of an engineer experienced in the design and construction of earth dams.

It is also recommended that a program of periodic inspections be implemented for this dam as soon as practical. The inspections should include, but not be limited to:

1. Monitoring seepage at the toe of the dam to identify changes in volume of flow or turbidity in the seepage water.

2. Inspection of the embankment for evidence of instability such as cracking or significant deformations.

Reports of inspections and any recommended maintenance should be made a matter of record.

WOODWARD-CLYDE CONSULTANTS

Richard G. Berggreen
Registered Geologist

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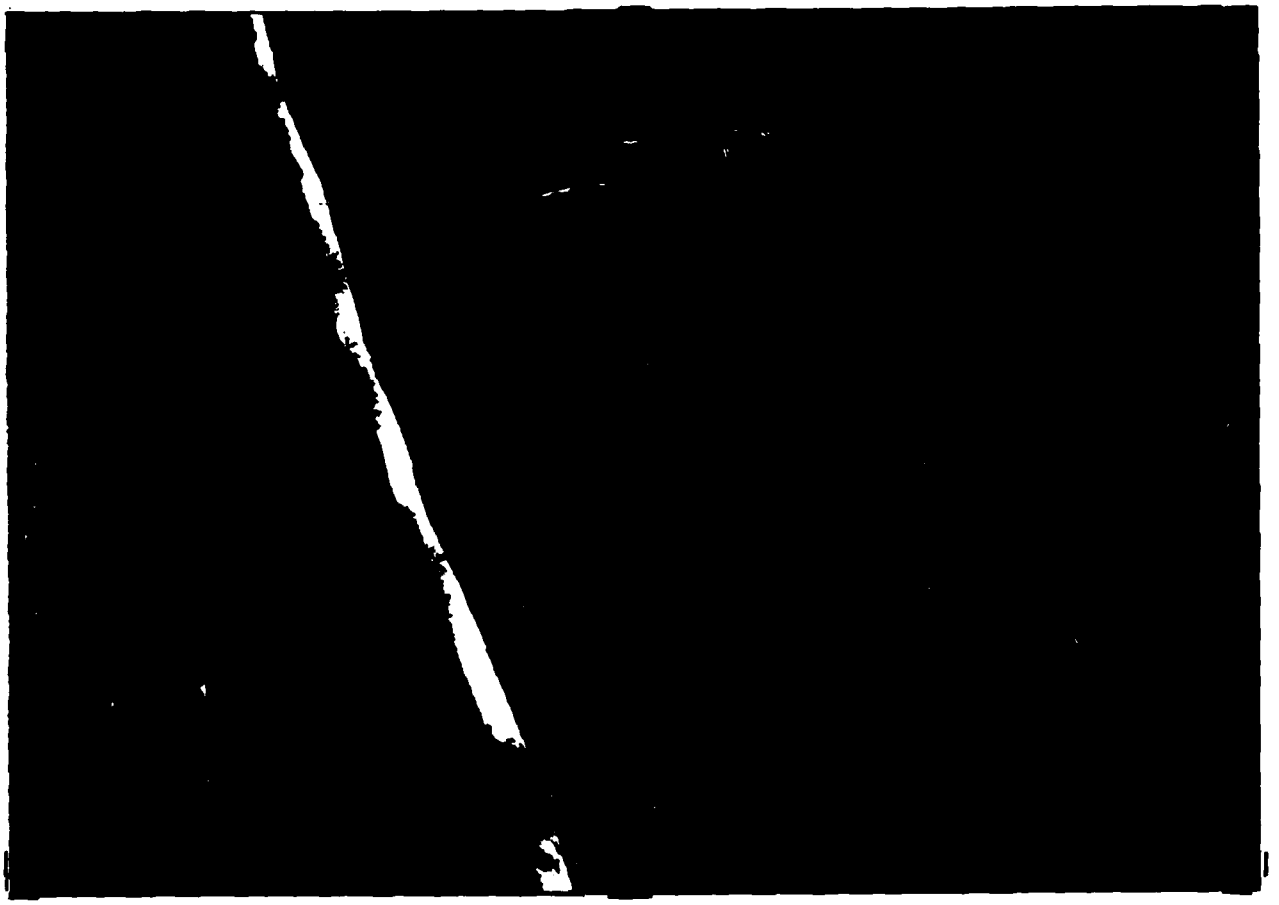

OVERVIEW
UPPER VALLE MINES DAM

MISSOURI INVENTORY NUMBER 30370

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
UPPER VALLE MINES DAM - MISSOURI INVENTORY NO. 30370

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3A. Plan of Dam Crest
3B. Dam, Spillway, and Discharge Channel Cross Sections
4. Regional Geologic Map

APPENDICES

A Figure A-1: Photo Location Sketch

Photographs

1. View along crest of dam. Note dense vegetation on upstream face (right) and downstream face (left). Looking east.
2. Dense vegetation on upstream face of dam, viewed from impoundment. Looking north.
3. Bullrock slope at toe of dam. Slope inclination approximately 1(H) to 1(V). Looking south.
4. Exposed chat, gravel-size tailings; near east end of embankment.
5. Small pool at toe of maximum section. Note dense vegetation on downstream face of dam. Looking north (downstream) from crest of dam.
6. Spillway area at left abutment. Impoundment is through trees in the distance. Looking south.
7. Reservoir area showing shallow pool and tailings deposits. Looking south.
8. Discharge channel flowing toward toe of dam. Dam is in trees to right of photo. Note gravelly soil on banks of channel. Looking east (downstream in channel).
9. Downstream hazard zone. Upper and Lower Valle Mines Dam out of picture to the right. Looking east.
10. Downstream hazard zone. Community of Valle Lake. Looking east. Upper Valle Mines Dam upstream (right) about 1.5 mi.
11. Valle Lake Dam approximately two miles below Upper Valle Mines Dam, within downstream hazard zone. Looking east.

B Hydraulic/Hydrologic Data and Analyses

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
UPPER VALLE MINES DAM, MISSOURI INVENTORY NO. 30370

SECTION 1
PROJECT INFORMATION

1.1 General

a. **Authority.** The National Dam Inspection Act, Public Law 92-367, provides for a national inventory and inspection of dams throughout the United States. Pursuant to the above, an inspection was conducted of Upper Valle Mines Dam (Mononame 215), Missouri Inventory Number 30370.

b. **Purpose of Inspection.** "The primary purpose of the Phase I investigation program is to identify expeditiously those dams which may pose hazards to human life or property... The Phase I investigation will develop an assessment of the general condition with respect to safety of the project based upon available data and a visual inspection, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted" (Chapter 3, "Recommended Guidelines for Safety Inspection of Dams").

c. **Evaluation criteria.** The criteria used to evaluate the dam were established in the "Recommended Guidelines for Safety Inspection of Dams", Engineering Regulation No. 1110-2-106 and Engineering Circular No. 1110-2-188, "National Program for Inspection of Non-Federal Dams", prepared by the Office of Chief of Engineers, Department of the Army, and "Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams" prepared by the St Louis District, Corps of Engineers (SLD). These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 Description of Project

a. **Description of dam and appurtenances.** The Upper Valle Mines Dam is an abandoned tailings dam constructed to impound sand, silt and clay tailings produced by the milling of barite ore.

Information on the construction of the dam was obtained from Mr David Haverstick, representative of Valle Mining Company, the reported owner of the dam.

The dam is reported to be primarily an earth embankment with a relatively thin mantle of gravel-size tailings (chat), and cobble- to boulder-size bullrock. The soil used to construct the dam is a dark-red, residual, plastic, stoney clay (CL-CH) obtained from the reservoir area. Both the upstream and downstream faces of the dam are heavily vegetated with brush and trees up to 18 in. diameter. The growth of dense vegetation is greater than is typical of most tailings dams in this area, but is probably the result of the dam embankment being mostly earth, rather than mostly chat.

The reservoir is nearly filled with fine tailings. Much of the impoundment area is densely vegetated with brush and trees. At the time of the visual inspection, water was covering approximately 50 percent of the impoundment. Mr Haverstick indicated the lake frequently dries up during the summer.

The spillway is a broad trapezoidal notch cut at the left abutment (as the observer faces downstream). The notch is cut into the native soil and will likely be moderately erodible during periods of flood flow.

The downstream channel consists of an earth-lined ditch excavated just beyond the toe of the dam. The slope of the channel indicates the spillway will be the controlling section for discharge from the reservoir. The slope of the channel also suggests that erosive velocities are likely in the channel during periods of substantial discharge.

b. **Location.** The dam is located on an unnamed tributary of Joachim Creek, about 6.6 miles south of the town of Desoto in Jefferson County, Missouri (Fig 1). The dam is located in Section 7, T38N, R5E, on the USGS Vineland 7.5 minute quadrangle map.

c. **Size classification.** The dam is classified a small size dam based on its height of 38 ft and storage capacity of approximately 145 ac-ft. A small dam is one between 25 and 40 ft in height or having a storage capacity between 50 and 1000 ac-ft.

d. **Hazard classification.** The St Louis District, Corps of Engineers has classified this dam as having a high hazard potential; we concur with this classification. The estimated damage zone length extends approximately 7 miles downstream of the dam, to the outskirts of the town of Desoto. Within this damage zone are numerous (15 to 20) vacation homes in the community of Valle Lake, approximately 2 miles from the dam. There are two dams, Lower Valle Mines Dam (MO 30439) and Lake Valle Dam (30438), and other scattered dwellings throughout the estimated damage zone.

e. **Ownership.** We understand the dam is owned by Valle Mining Company, 11 South Meremac, Suite 1314, Clayton, Missouri 63105.

f. **Purpose of dam.** Upper Valle Mines Dam was constructed to impound fine barite tailings produced by the washing of barite ore mined in the vicinity. Water impounded by the dam was recycled from the reservoir and used in the barite processing operation.

g. **Design and construction history.** Information on the design and construction history was obtained from interviews with Mr David Haverstick, superintendent for Valle Mining Company, the reported owner of the dam. Other than the recollection of Mr Haverstick, no records of the design or construction could be found for this dam.

The dam was constructed in the early 1950's. It was constructed of residual soil borrowed from the reservoir area. Compaction was limited to the equipment traffic on the dam.

Following construction of the earth dam, chat (gravel and sand tailings) and bullrock (cobble and boulder tailings) were dumped on the dam and form a mantle over the earth core. As a result of this tailings mantle, the main earth embankment was not exposed and could not be observed during the field inspection.

The processing plant has not operated for an extensive period of time. Operations at the plant and dam were terminated in the late 1950's and the facility has remained inactive since then.

h. **Normal operating procedures.** The dam is currently abandoned and there are no operating procedures in effect at this facility.

1.3 Pertinent Data

a. **Drainage area.** approximately 0.24 mi^2 (Fig 2)

b. **Discharge at damsite.**

Maximum known flood at damsite	Unknown
Warm water outlet at pool elevation	N/A
Diversion tunnel low pool outlet at pool elevation	N/A
Diversion tunnel outlet at pool elevation	N/A
Gated spillway capacity at pool elevation	N/A
Gated spillway capacity at maximum pool elevation	N/A
Ungated spillway capacity at maximum pool elevation (Spillway crest at nearly same elevation as minimum top of dam)	7 ft^3/sec
Total spillway capacity at maximum pool elevation	7 ft^3/sec

c. **Elevation (ft above MSL).**

Top of dam (as measured along centerline)*	826.6 to 829.8 (Fig 3A)
Maximum pool-design surcharge	N/A
Full flood control pool	N/A
Recreation pool	N/A
Spillway crest (gated)	N/A
Upstream portal invert diversion tunnel	N/A
Downstream portal invert diversion tunnel	N/A
Streambed at centerline of dam	Unknown
Toe of dam at maximum section	788.6
Maximum tailwater	N/A

*Chat piled along upstream edge of dam is typically 1 to 3 ft higher than centerline of dam (see Fig 3B, Maximum Section). For overtopping analyses the low point along the crest was taken at elevation 827.7.

d. **Reservoir.**

Length of maximum pool	Approximately 900 ft
Length of recreation pool	N/A
Length of flood control pool	N/A

e. **Storage (acre-feet).**

Recreation pool	N/A
Flood control pool	N/A
Design surcharge	N/A
Top of dam	145 (includes volume of fine tailing)

f. **Reservoir surface (acres).**

Top of dam	13
Maximum pool	13
Flood-control pool	N/A
Recreation pool	N/A
Spillway crest	13

g. **Dam.**

Type	Tailings (rolled earth and coarse tailings, impounding fine tailings)
Length	Approximately 985 ft
Height	38 ft
Crest width	15 to 20 ft (typical)
Side slopes	Downstream, 1.6(H) to 1(V) Upstream, 2.1(H) to 1(V) on exposed portion
Zoning	Stoney clay earth dam with thin mantle of gravel and rock
Impervious core	Unknown, probably none
Cutoff	Unknown, probably one to shallow rock
Grout curtain	Unknown, probably none

h. **Diversion and regulating tunnel.**

Type	None
Length	N/A
Closure	N/A
Access	N/A
Regulating facilities	N/A

i. **Spillway.**

Type	Unlined, trapezoidal notch at left abutment
Length of weir	Approximately 48 ft at level of adjacent dam crest, 29 ft effective width
Crest elevation	827.5
Gates	None
Upstream Channel	None
Downstream Channel	Unlined channel in residual soil

j. **Regulating outlets.** None

SECTION 2
ENGINEERING DATA

2.1 Design

No design drawings or data were found for this dam.

2.2 Construction

No construction records or data were found. Information on the construction was obtained from interviews with Mr David Haverstick of Valle Mining Co.

The dam was constructed of soil borrowed from the reservoir area. Compaction during construction was limited to construction traffic and dozers. A mantle of chat and bullrock was placed on the dam surface by dumping from the crest. This was added after the processing plant went into operation.

2.3 Operation

No records were found for reservoir water elevation or spillway discharge history. The dam is currently abandoned.

2.4 Evaluation

a. **Availability.** No data relative to the design of the dam were available for review.

b. **Adequacy.** Insufficient data were available to determine the adequacy of the design.

Seepage and stability analyses comparable to the requirements of the guidelines are not on record. These analyses should be performed by an engineer experienced in the design and construction of dams. Further, these seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. **Validity.** There is no reason to question the validity of the information obtained from Mr Haverstick. He was employed by the Valle Mining Company at the time of dam construction. His description of the construction is comparable to other dams in the area and not in conflict with field observations during our inspection.

2.5 Project Geology

The dam site is located on the northern flank of the Ozark structural dome. The regional dip is to the north. Bedrock in the area is mapped on the Geologic Map of Missouri (1979) as Cambrian age Potosi and Eminence dolomite formations (Fig 4). The Potosi Formation is a medium- to fine-grained, light gray dolomite and typically contains an abundance of quartz druse characteristic of chert bearing formations. The Eminence Formation conformably overlies the Potosi Formation, is similar in appearance but contains less chert and quartz. Large caves and springs are found in the Eminence Formation in parts of Missouri. The owner's representative described several large springs downstream from this dam. However, no evidence of solution activity or springs was noted during the visual inspection.

Two soils were identified in the vicinity of the dam. The upper soil was a light brownish-gray clayey silt (ML), apparently a loess horizon, about 3 ft thick. This was underlain by a dark red-brown, plastic, stoney residual clay (CL-CH), apparently a residual soil developed on the weathered dolomite bedrock. The soil contained chert and quartz druse fragments from the bedrock. This residual clay was likely the soil used in the construction of the earthen dam. The area is mapped on the Missouri General Soils Map as Union-Goss-Gasconade-Peridge Association.

The Valle Mines-Vineland Fault zone is mapped on the Structural Features Map of Missouri (1971) approximately 1 mi northeast of the damsite. This fault zone is approximately 22 miles in length, trends northwest-southeast, and is mapped as southwest side up. This fault zone, like most others in the Ozark area, is likely Paleozoic in age, and is not considered to be in a seismically active area. The fault is not considered to pose a significant hazard to the dam.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. **General.** The field inspection of the Upper Valle Mines Dam was conducted on 15 August 1980. Mr David Haverstick of Valle Mining Company met with the inspection team at the site but did not accompany them throughout the inspection.

b. **Dam.** The Upper Valle Mines Dam is densely vegetated with brush and trees on both the upstream and downstream faces (Photos 1 and 2; Appendix A). This dense vegetation obstructed much of the dam face from a thorough visual inspection. The vegetation ranged from dense brush to trees as large as 18 in. diameter.

No evidence of disruption of the vertical or horizontal alignment of the dam crest was noted. No sinkholes, excessive settlement, cracking or animal burrows were noted. There was abundant evidence of beaver activity in the area adjacent to the reservoir. Beaver dams could obstruct the spillway during flood flows emphasizing the importance of periodic inspections and maintenance.

A small slump was noted on the downstream face of the dam near the toe of the maximum section. This slump appeared well vegetated and did not appear to be a recent feature. Other irregularities were noted on the downstream face but could be attributed to construction techniques rather than to slope movements. However, the dense vegetation makes this assessment equivocal.

The downstream face of the dam is quite steep, averaging approximately 1.6(H) to 1(V), (Fig 3B). Portions of the slope with a mantle of bullrock cobbles and boulders, are as steep as 1(H) to 1(V), (Photo 3). The exposed portion of the upstream slope is slightly flatter at about 2.1(H) to 1(V). Erosion protection is provided for by the vegetation present on the dam. The potential for erosion is low on the upstream face due to the presence of the vegetation and the short fetch of the reservoir.

Minor gully erosion was noted on the exposed portion of the downstream face. The dense vegetation probably offers some erosion protection. The chat mantle, exposed at the east end of the embankment, is judged to be highly erodible for flow velocities of 5.0 ft/sec or greater, such as that created on the steep downstream face during potential overtopping (Photo 4).

Seepage was noted at the toe of the dam. A small shallow pool at the toe appears to collect both overland runoff and seepage and is partially constrained by a downstream roadway approximately parallel to the dam (Photo 5). The volume of seepage was estimated at 1 to 2 gal/min but did not appear to have a single source, rather a broad damp area of slow seepage. The seepage water did not appear to be carrying any soil in the flow.

c. **Appurtenant structures.**

Spillway. The spillway is a broad low area apparently excavated into natural soil at the west end of the dam (Photo 6). This area is densely vegetated with weeds and low brush. It is likely some obstruction would occur in this area during flood flows.

There is approximately a 5 ft elevation difference between the high point (top of chat pile) of the adjacent end of the embankment and the crest of the spillway. However, the field survey conducted on this dam indicates the low point on the dam crest is only 0.2 ft higher in elevation than the spillway crest. Therefore, the water surface elevation which will cause discharge through the spillway will be very close to causing overtopping of portions of the embankment.

Substantial flows through the spillway would likely cause erosion of the residual soil which forms the spillway floor. However, significant erosion is unlikely due to the probable shallow depth to bedrock. Erosion in the spillway is unlikely to pose a hazard to the dam due to the distance from the maximum section of the embankment.

d. **Reservoir area.** The reservoir at the time of the inspection was nearly filled with fine tailings (Photo 7). Only a relatively shallow pool was present in the impoundment area. The owner's representative, Mr Haverstick, indicated the lake frequently dries up during the summer.

The slopes around the reservoir and surrounding area are heavily wooded, and are not expected to supply much siltation to the impoundment. The slopes are relatively gentle, 5(H) to 1(V), or flatter, and no evidence of unstable slopes was identified during the field inspection.

e. **Downstream channel.** The downstream discharge channel consists of a notch cut into the natural soil approximately 25 to 40 ft from the toe of the embankment (Photo 8). The slope of the channel appears to be steep enough to experience velocities sufficient to erode the soils. However, erosion of the channel should not pose a hazard to the dam as the channel is located away from the toe of the dam. Some scattered brush and weeds are present in the downstream channel, but do not appear sufficient at present to obstruct flow in the channel.

3.2 Evaluation.

The visual inspection indicates the dam is in generally poor condition. The embankment is densely vegetated and vegetation obscured parts of the dam from accurate inspection. No evidence was noted of disruption of the vertical or horizontal alignment of the dam crest. No evidence was noted of sinkhole development, cracking, excessive settlement, or animal burrows. Minor gully erosion was noted on the downstream face. A small slump was identified on the downstream face but appeared well vegetated and likely is an old feature. The vegetation on the dam offers moderate erosion protection; however, the dam materials are in part highly erodible in the event of overtopping of the embankment.

Surveying indicated the spillway crest is only slightly lower than the minimum top of dam elevation. As a result, outflow at the spillway will occur only when reservoir levels are close to overtopping the dam.

Erosion in the spillway and downstream channel are not expected to pose a hazard to the dam due to their distance from the maximum section.

Seepage appeared minor and did not appear to pose a hazard to the dam.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

The dam is currently abandoned and there are no operational procedures for this dam. The water level is controlled by the crest of the spillway.

4.2 Maintenance of Dam

No records of maintenance on this facility were available.

4.3 Maintenance of Operating Facilities

There are no operating facilities requiring maintenance at this dam.

4.4 Description of Any Warning System in Effect

The inspection did not find any warning system in effect at this facility.

4.5 Evaluation

There are apparently no maintenance or operational procedures in effect. The lack of regular maintenance and periodic inspection is considered a deficiency.

The feasibility of a practical warning system should be evaluated to provide early warning to downstream residents should potentially hazardous conditions develop during periods of heavy precipitation.

SECTION 5
HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. **Design data.** No hydrologic or hydraulic design data were available for evaluation of this dam or reservoir. Elevations and dimensions of pertinent features were field surveyed 8 August 1980. Other relevant data were estimated from topographic maps. The map used in the analysis was the USGS 7.5-minute quadrangle map for Vineland, Missouri (1960).

b. **Experience data.** No recorded history of rainfall, runoff, discharge, overtopping or pool stage data were found for this site.

c. **Visual observations.**

1. Watershed. The entire watershed is wooded, forested with mixed hardwoods and softwoods. The total drainage area is approximately 0.24 square miles, of which approximately 8 percent is the reservoir.

2. Reservoir. The reservoir and dam are best described by the maps and photographs enclosed herewith. The purpose of this impoundment is for the storage of mine tailings. The reservoir is nearly filled with fine-grained mine tailings.

3. Spillway. The uncontrolled, unlined spillway is approximately trapezoidal in shape and is located at the northwest end of the dam embankment abutting the natural hillside (left abutment). Tree growth on the spillway has advanced to a height of over 20 feet. Just below the crest, the discharge channel curves and drops toward the toe of the center portion of the dam. Based on the steepness of this channel, it is reasonable to assume that the spillway serves as the control section for flow.

4. Seepage. The magnitude of seepage through the embankment is not hydrologically significant to the overtopping potential.

d. **Overtopping potential.** One of the primary considerations in the evaluation of Upper Valle Mines Dam is the assessment of the potential for overtopping and consequent failure by erosion of the embankment. As the spillway of this dam is not lined, erosion due to high velocity discharge is likely. The lowest portion of the dam crest is at the northeast end of the dam where the dam crest is only marginally higher (0.2 ft) than the spillway crest elevation. For the purpose of determining the overtopping potential, spillway outflow of approximately 7 cubic feet per second is considered to produce the effects of overtopping.

Analyses of this impoundment for the 1 and 10 percent probability-of-occurrence floods and for the maximum percent of the PMF which would not cause overtopping were based on a starting water surface elevation at the upper mudline of the tailings. This elevation, which is higher than the normal pool elevation, was chosen in the absence of any other positive high water marks. For the 50 and 100 percent of the Probable Maximum Floods (PMF), the starting water surface was assumed at the spillway crest level, since the antecedent storms would have resulted in full reservoirs in both cases. The PMF is defined as the flood event which may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

The results of the analyses indicate that a flood of greater than 10 percent of the PMF will effectively overtop the dam. A flood with 1 percent probability-of-occurrence is likely to overtop the low points on the dam by approximately 0.4 feet. The 10 percent probability-of-occurrence flood will be contained in the reservoir. At floods equal to or greater than 50 percent of the PMF, erosion of the spillway will probably take place. If the dam is overtopped, it is likely that the downstream face of the dam will be eroded due to the velocity and turbulence created by the steepness of the dam face.

The following results were obtained for the dam from the hydrologic/hydraulic analyses:

Precipitation Event	Maximum Reservoir Elevation, ft (MSL)	Maximum Depth of Overtopping, ft	Maximum Outflow, ft^3/sec	Duration of Overtopping, hrs
1% Prob	828.1	0.4	160	8.2
10% PMF	827.5	0	1	0
50% PMF	828.5	0.8	822	26.0
100% PMF	828.9	1.2	1670	29.7

Downstream from Upper Valle Mines Dam (within approximately 2 miles) are two dams, Lower Valle Mines Dam (MO 30439) and Lake Valle Dam (MO 30438). The depth, duration and total outflow of overtopping of Upper Valle Mines Dam indicate a high potential for failure of this dam creating an increased hazard to the downstream dams, residents and structures. Due to the severity of the 50 percent PMF event, the potential for dam failure, the proximity of resident and dams downstream, it is recommended that the spillway design flood be taken as 100 percent of the PMF.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. **Visual observations.** The visual inspection of Upper Valle Mines Dam revealed no evidence of horizontal or vertical displacement of the dam crest alignment. No evidence of cracking, detrimental settlement, or depressions was observed. A small slump was noted on the face of the dam but appeared to be an old feature.

b. **Design and construction data.** No design or construction data relating to the stability of the dam were available. Seepage and stability analyses comparable to the requirements of the recommended guidelines were not available. This is considered a deficiency.

c. **Operating records.** No operating records were available.

d. **Post construction changes.** The lack of drawings or construction reports precludes identification of post construction changes. However, no obvious changes were observed, other than the growth of the dense vegetation on the upstream and downstream faces of the dam.

e. **Seismic stability.** The dam is in Seismic Zone 2, to which the guidelines assign a moderate damage potential. Since no static stability analysis is available for review, the seismic stability cannot be evaluated. However, the stoney clay used in the construction of the embankment does not appear to be subject to liquefaction during a seismic event.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

a. **Safety.** Based on the findings of the visual inspection and the evaluation of the available data, the Upper Valle Mines Dam is judged to be in generally poor condition. This judgment is due to the inability of the spillway to pass the one percent probability-of-occurrence event without overtopping the embankment, the hazard of erosion posed to the embankment in the event of overtopping, the dense vegetation on the embankment, as well as the steep slopes and evidence of past slumping on the downstream face of the dam. The lack of seepage and stability analyses as required by the recommended guidelines is considered a deficiency. The lack of periodic inspections and maintenance of the dam and spillway is also considered a deficiency.

The amount and duration of total outflow for this dam will jeopardize the safety of the downstream residents and dams. The total outflow from this dam is likely to inundate some downstream structures as shown in Photos 9, 10 and 11. The severity of inundation and damage is unknown without further studies.

b. **Adequacy of information.** The lack of design and construction data and of stability and seepage analyses for this dam as recommended in the guidelines precludes an evaluation of the structural and seismic stability of the dam. This is considered a deficiency.

c. **Urgency.** The deficiencies described in this report could affect the safety of the dam. The remedial measures or studies that should be initiated without undue delay to prevent deterioration of the dam to a hazardous condition, are described in Section 7.2b.

d. **Necessity for Phase II.** In accordance with the "Recommended Guidelines for Safety Inspections of Dams", the subject investigation was a minimum study. This study revealed that additional in-depth investigations are needed to complete the assessment of the safety of the dam. Those investigations which

should be performed without undue delay are described in Section 7.2b. It is our understanding from discussions with the St Louis District that any additional investigations are the responsibility of the owner.

7.2 Remedial Measures

a. **Alternatives.** There are several general options which may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Remove the dam, or breach it to prevent storage of water.

2. Increase the height of dam and/or spillway size to pass the probable maximum flood without overtopping the dam.

3. Purchase downstream land that would be adversely impacted by dam failure and restrict human occupancy.

4. Provide a highly reliable flood warning system (generally does not prevent damage but diminishes the chances for loss of life).

b. **Recommendations.** Based on our inspection of Upper Valle Mines Dam, it is recommended that further study be conducted and remedial measures taken without undue delay to:

1. Increase the height of the dam and/or the capacity of the spillway to safely pass 100 percent of the PMF without overtopping. This is deemed to be an appropriate spillway design flood in view of the large number of dwellings within 2 miles downstream of the dam, evidence of past slumping on the downstream slope and the potential erodibility of the materials in the event of overtopping.

The following items should be investigated and the appropriate action taken as soon as practical:

2. Removal of large trees and control of detrimental vegetation on the embankment. This study should also include methods of controlling vegetation in the spillway and discharge channel. Removal of large trees should be done under the guidance of an engineer experienced in the design and construction of dams. Indiscriminate clearing may jeopardize the safety of the dam.

3. Performance of seepage and stability analyses of the dam comparable to those required in the "Recommended Guidelines for Safety Inspection of Dams".

4. Evaluation of the practicality of a warning system for alerting downstream residents, should unsafe emergency conditions develop at the dam.

All action should be conducted under the guidance of an engineer experienced in the design and construction of earth dams.

c. **Operation and maintenance procedures.** A program of periodic inspections should be implemented for this dam as soon as practical. The inspections should include, but not be limited to:

1. Monitoring seepage at the toe of the dam to identify changes in volume of flow or turbidity in the seepage water.

2. Inspection of the embankment for evidence of instability such as slope deformation, cracking or settling.

Reports of inspections and any recommended maintenance should be made a matter of record.

REFERENCES

Allgood, Ferris P., and Persinger, Ivan, D., 1979, "Missouri General Soil Map and Soil Association Descriptions," US Department of Agriculture, Soil Conservation Service and Missouri Agricultural Experiment Station.

Department of the Army, Office of the Chief of Engineers, 1977, EC 1110-2-188, "National Program of Inspection of Non-Federal Dams".

Department of the Army, Office of the Chief of Engineers, 1979, ER 1110-2-106, "National Program of Inspection of Non-Federal Dams".

Hydrologic Engineering Center, US Army Corps of Engineers, 1978, "Flood Hydrograph Package (HEC-1) Users Manual for Dam Safety Investigations".

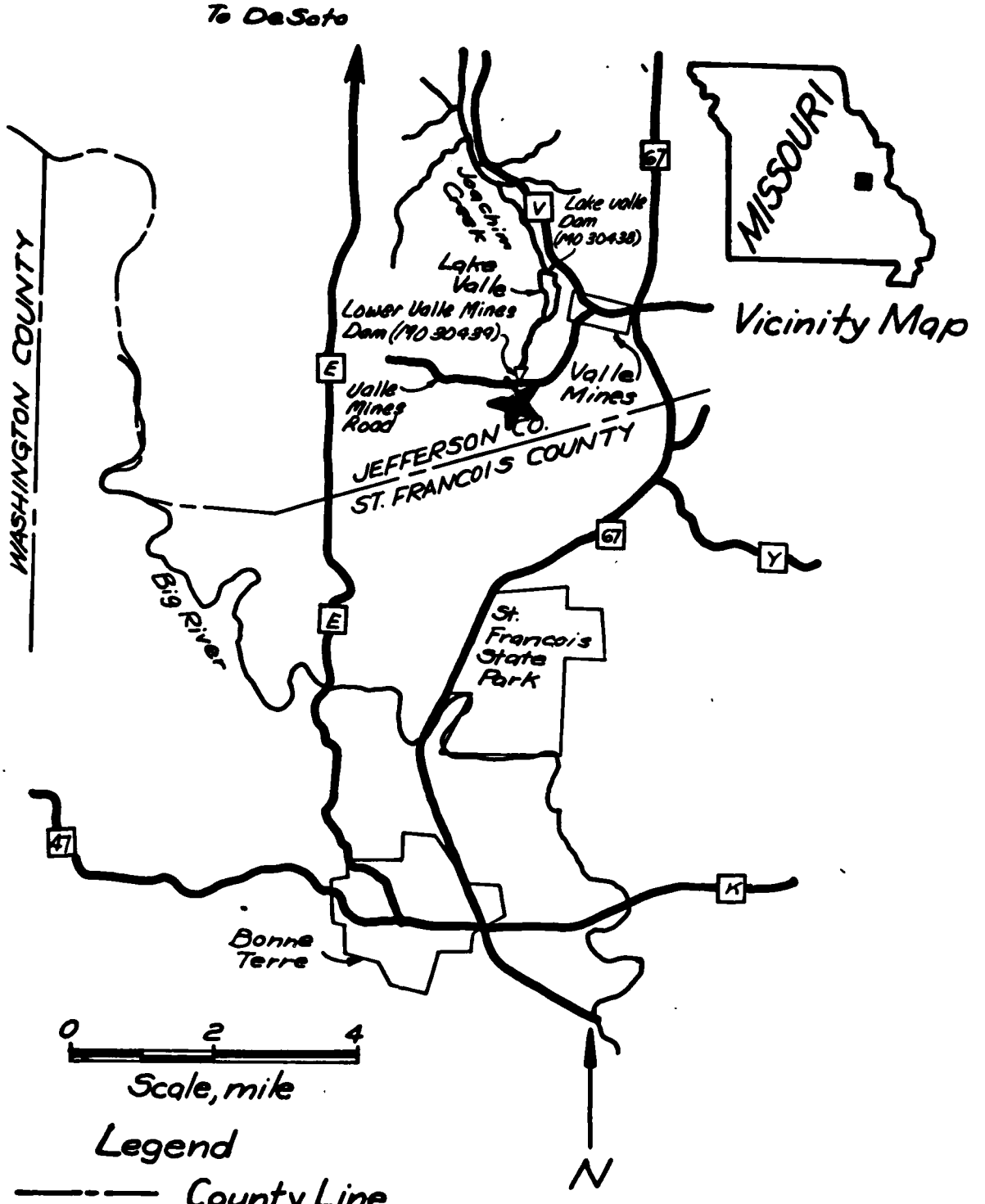
McCracken, Mary H., 1971, Structural Features Map of Missouri: Missouri Geological Survey, Scale 1:500,000.

Missouri Geological Survey, 1979, Geologic Map of Missouri: Missouri Geological Survey, Scale 1:500,000.

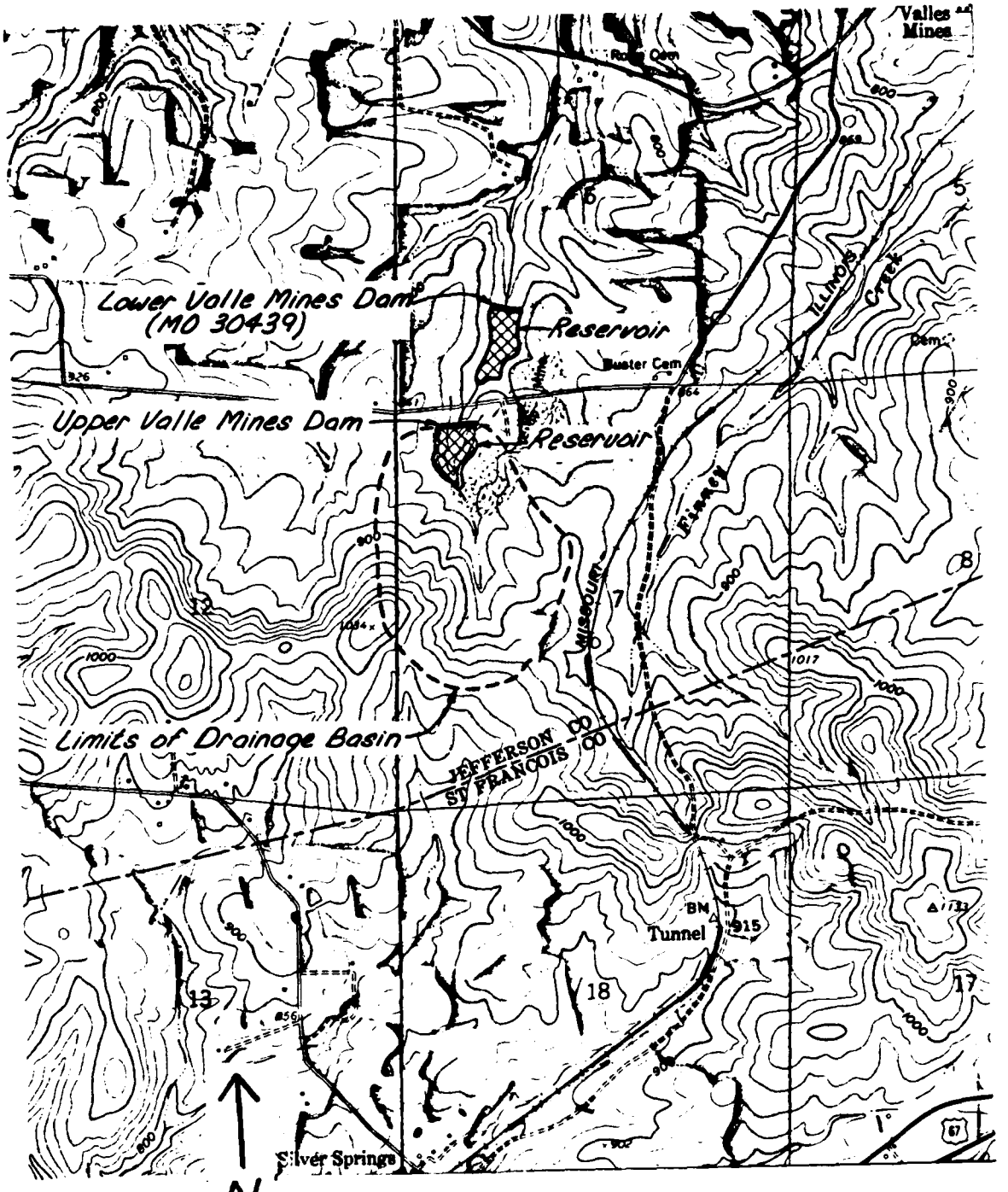
St Louis District, US Army Corps of Engineers, 1979, "Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams".

US Department of Commerce, US Weather Bureau, 1956, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours," Hydrometeorological Report No. 33.

US Soil Conservation Service, 1971, "National Engineering Handbook," Section 4, Hydrology, 1971.

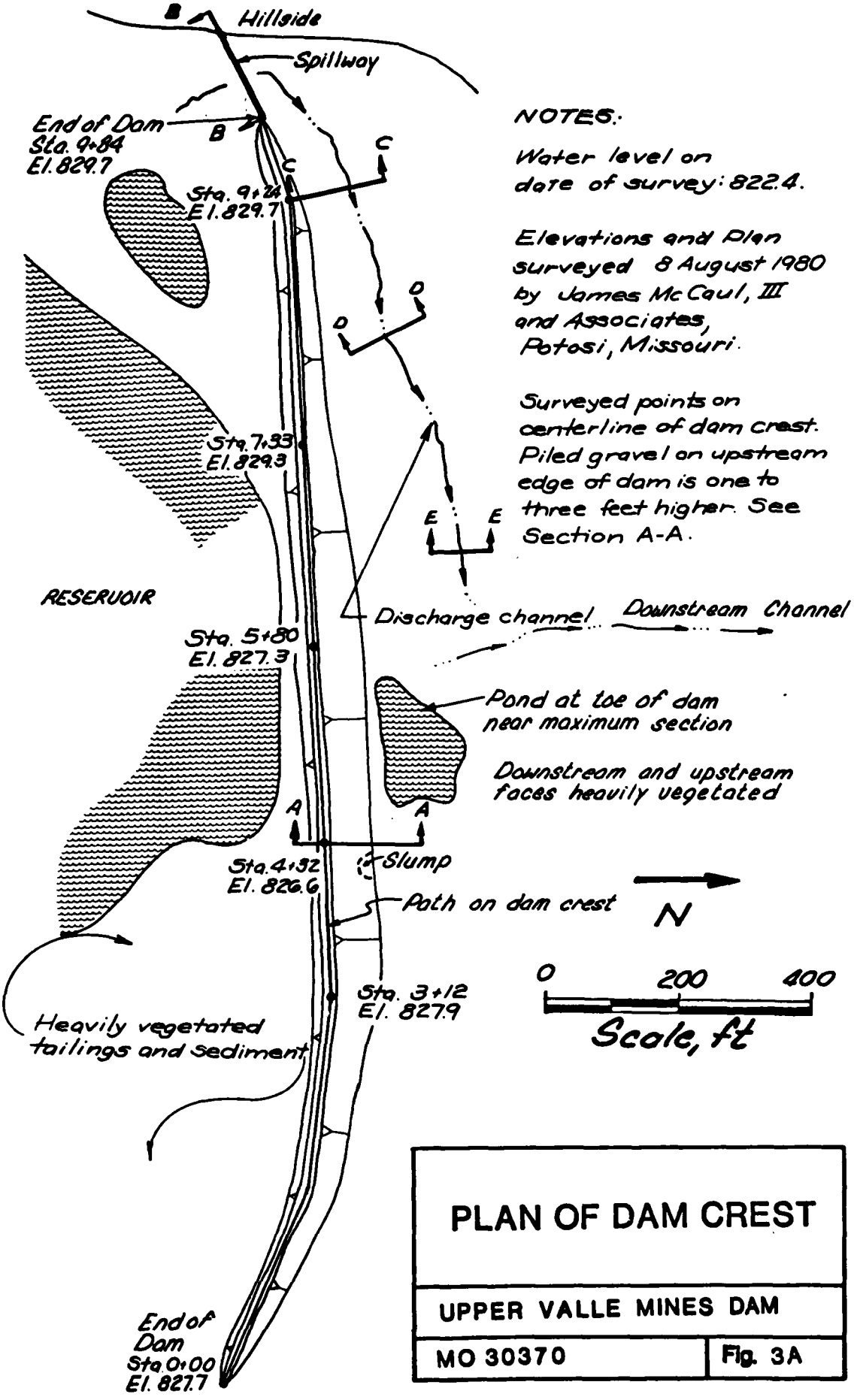


SITE LOCATION MAP	
UPPER VALLE MINES DAM	
MO 30370	Fig. 1



Note: Topography from USGS Vineland, Missouri 7.5 minute quadrangle map (1960)

DRAINAGE BASIN AND SITE TOPOGRAPHY	
UPPER VALLE MINES DAM	
MO 30370	Fig. 2



NOTES:

Water level on date of survey: 822.4.

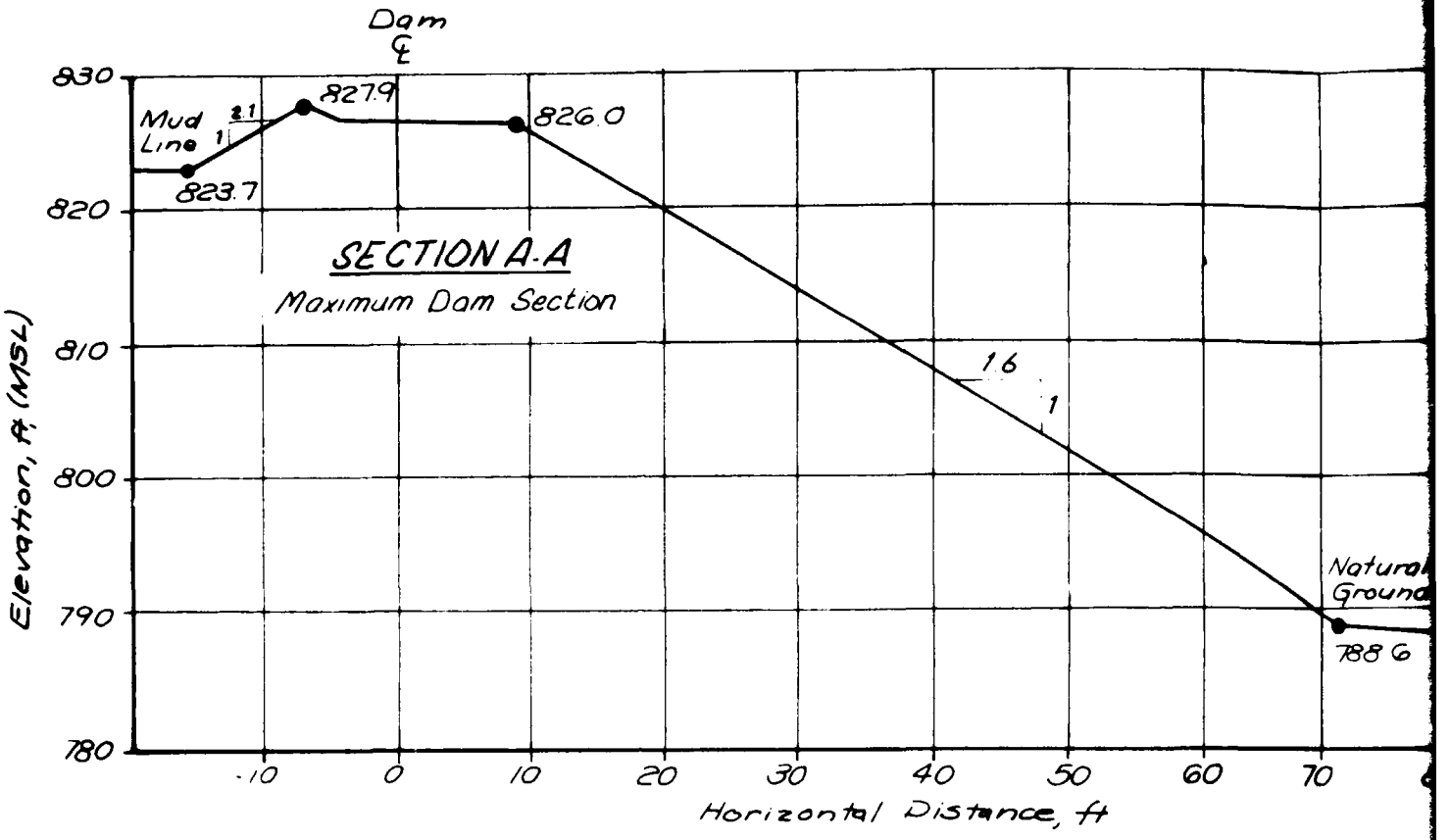
Elevations and Plan surveyed 8 August 1980 by James McCaul, III and Associates, Potosi, Missouri.

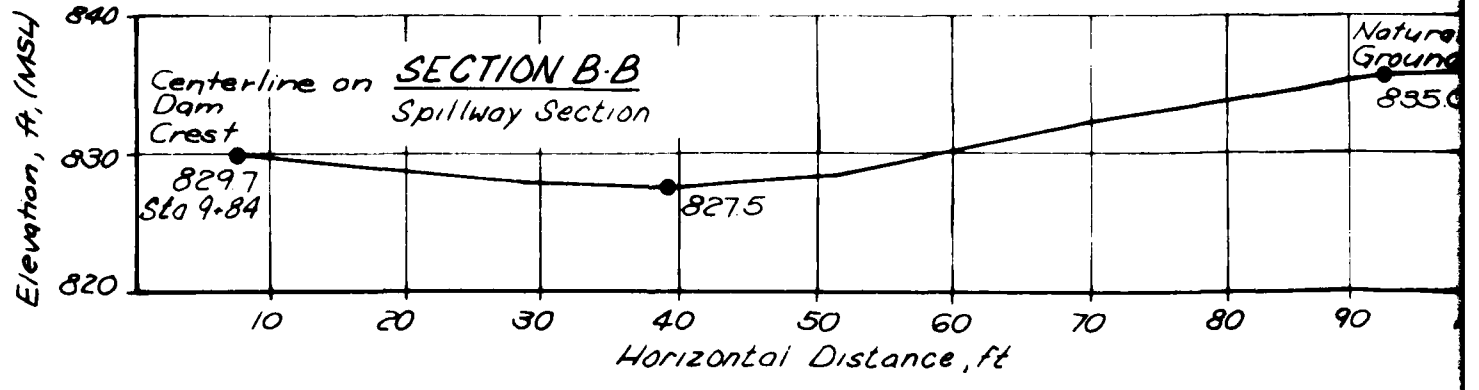
Surveyed points on centerline of dam crest. Piled gravel on upstream edge of dam is one to three feet higher. See Section A-A.

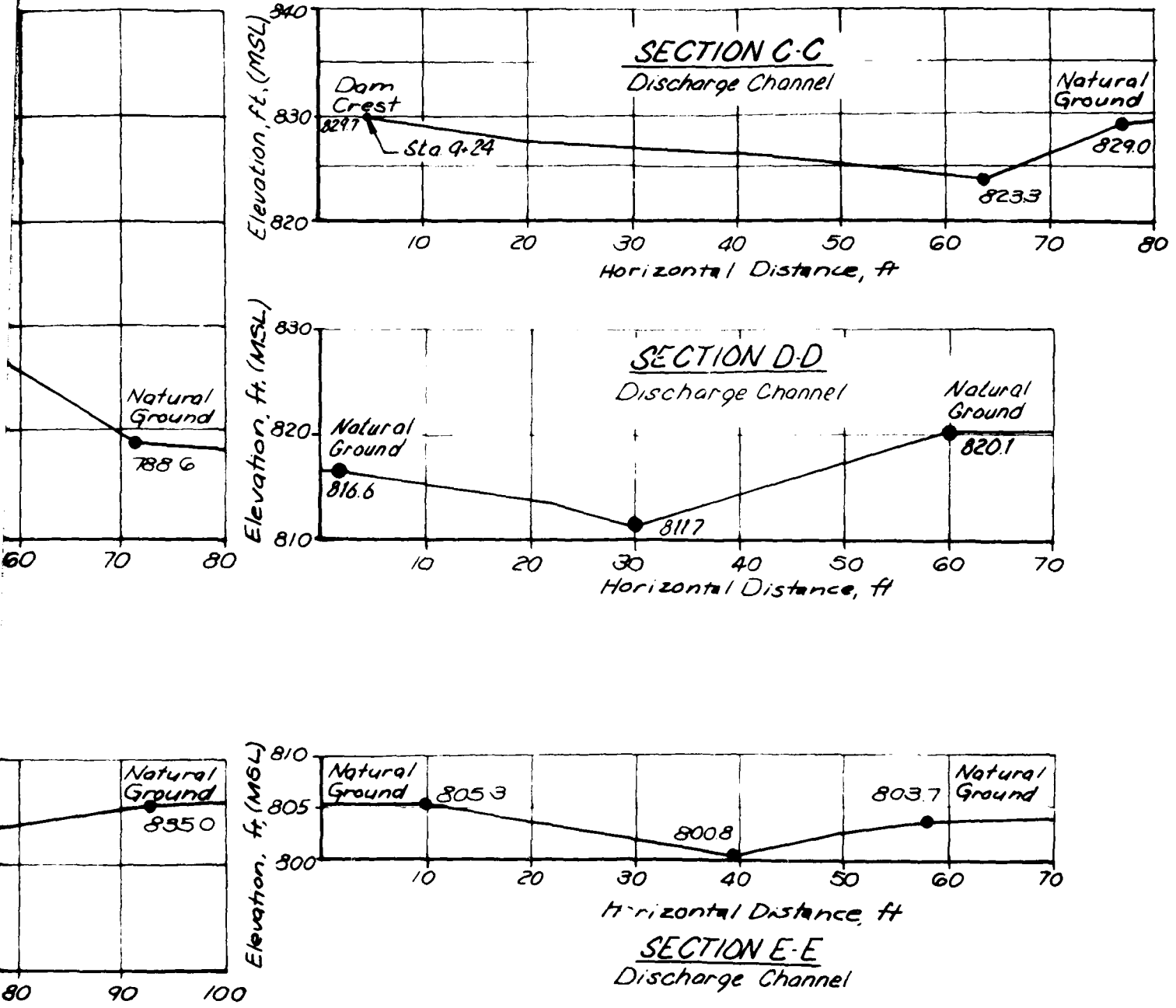
PLAN OF DAM CREST

UPPER VALLE MINES DAM

MO 30370 | Fig. 3A


Dam
℄
830
820
810
800
790
780
Mud Line
2:1
1
827.9
826.0
823.7
SECTION A-A
Maximum Dam Section
1.6
1
Natural Ground
788.6
Elevation, ft. (MSL)
-10
0
10
20
30
40
50
60
70
Horizontal Distance, ft


840
830
820
Centerline on Dam Crest
SECTION B-B
Spillway Section
829.7
Sta 9+84
827.5
Natural Ground
835.0
Elevation, ft. (MSL)
10
20
30
40
50
60
70
80
90
Horizontal Distance, ft



DAM, SPILLWAY, AND DISCHARGE CHANNEL CROSS SECTIONS	
UPPER VALLE MINES DAM	
MO 30370	Fig. 3-B

Legend

- Ojc — Smithville Formation, Powell Dolomite, Cotter Dolomite, Jefferson City Dolomite
- Or — Roubidoux Formation
- Gasconade Dolomite
  - Gunter Sandstone Member
- Cep — Eminence Dolomite
- Cep — Potosi Dolomite
- Derby-Doerun Dolomite
- Davis Formation
- Ceb — Bonneterre Formation
  - Whetstone Creek Member
  - Sullivan Siltstone Member
- Reagan Sandstone
- Lamotte Sandstone
- Diabase (dikes and sills)
- St. Francois Mountains Intrusive Suite
- St. Francois Mountains Volcanic Supergroup

REGIONAL GEOLOGIC MAP

UPPER VALLE MINES DAM

MO 30370 | Fig. 4

APPENDIX A

Photographs

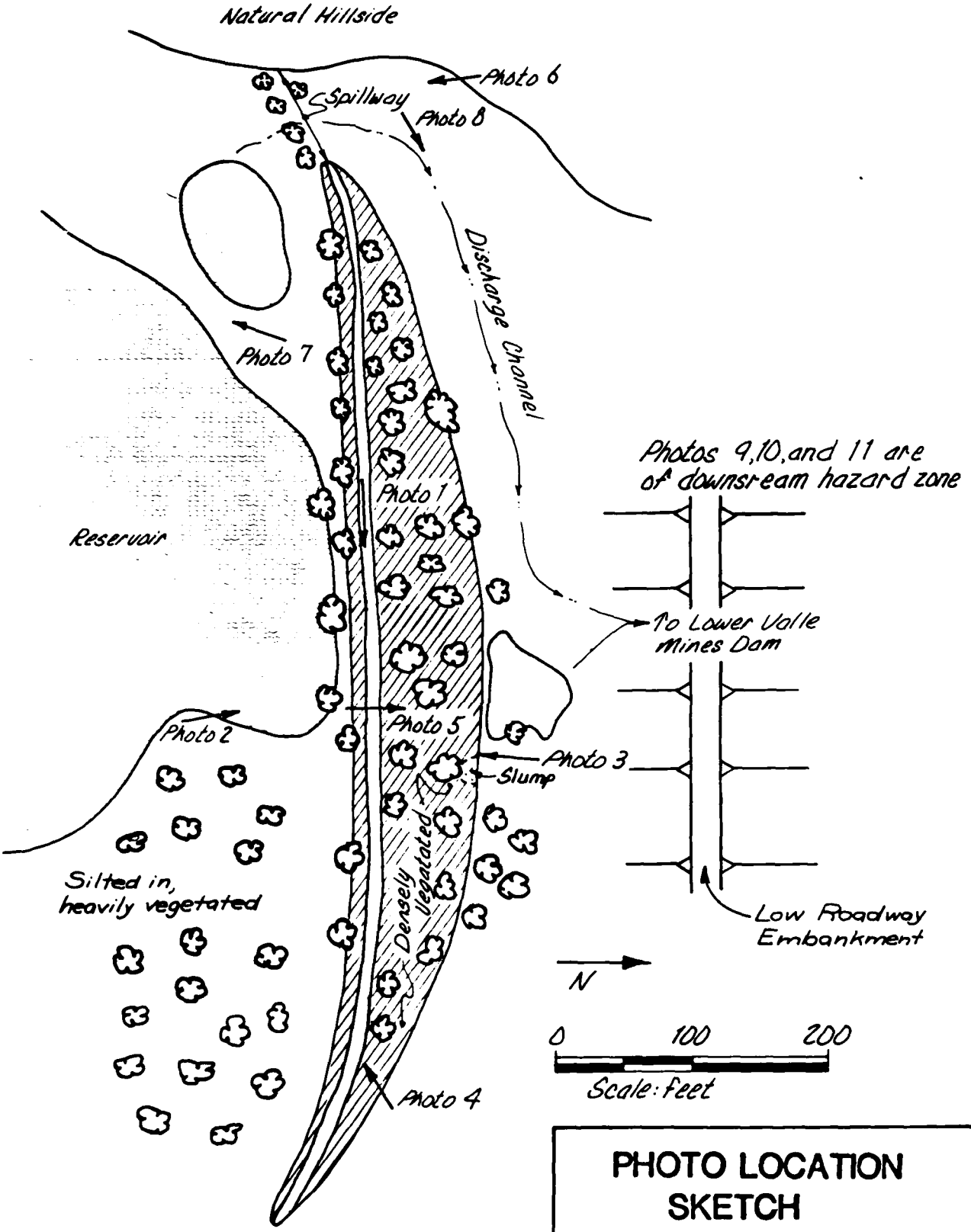


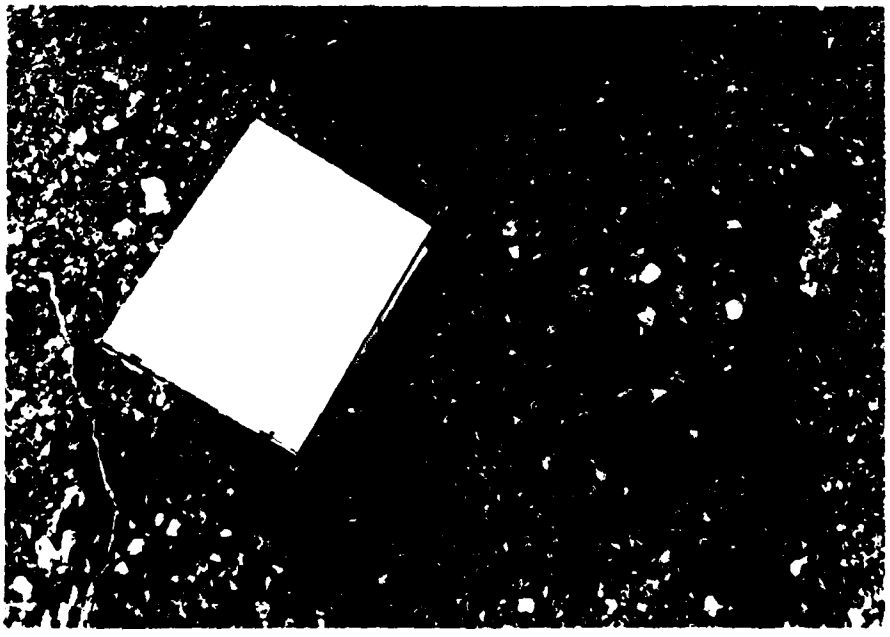
PHOTO LOCATION SKETCH

UPPER VALLE MINES DAM	
MO 30370	Fig. A-1

1. View along crest of dam. Note dense vegetation on upstream face (right) and downstream face (left). Looking east.

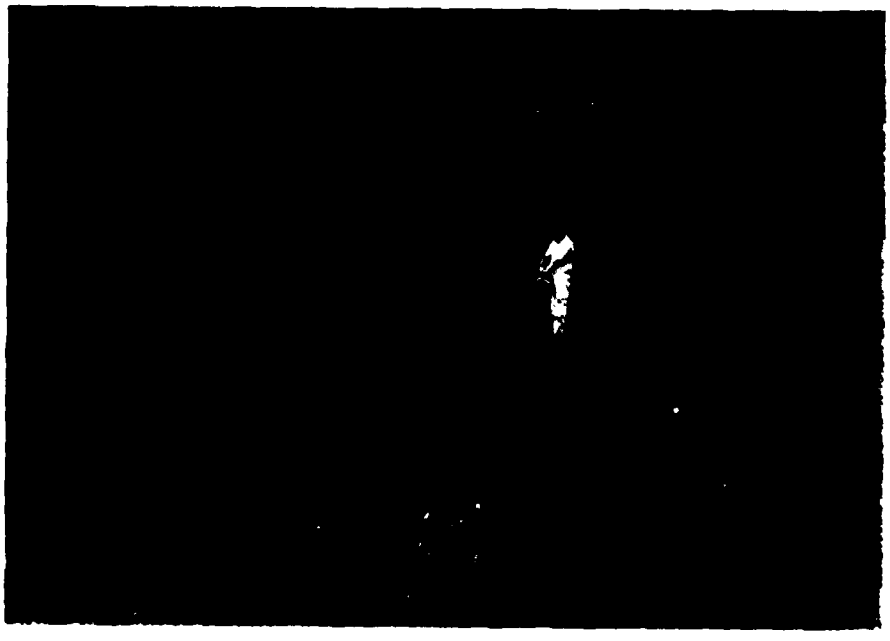
2. Dense vegetation on upstream face of dam, viewed from impoundment. Looking north.

3. Bullrock slope at toe of dam. Slope inclination approximately 1(H) to 1(V). Looking south.



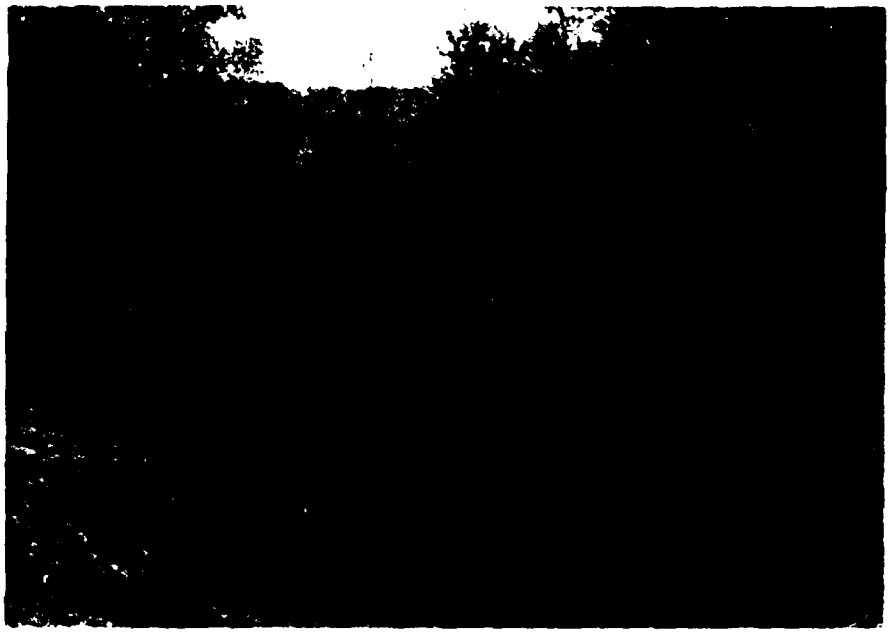
4. Exposed chat, gravel-sized tailings; near east end of embankment.

5. Small pool at toe of maximum section. Note dense vegetation on downstream face of dam. Looking north (downstream) from crest of dam.

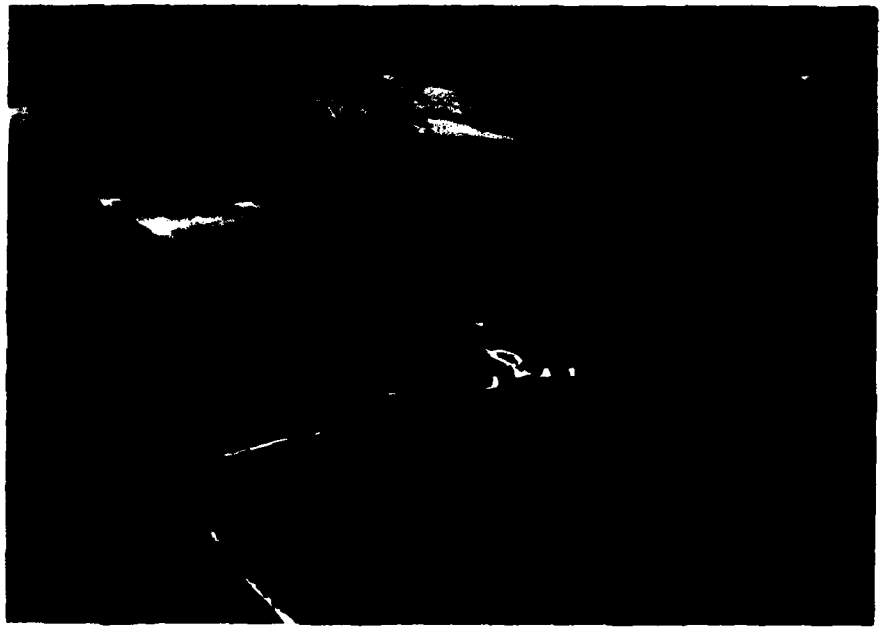


6. Spillway area at left abutment. Impoundment is through the trees in the distance. Looking south.

7. Reservoir area showing shallow pool and tailings deposits. Looking south.



8. Discharge channel flowing towards toe of dam. Dam is in trees to right of photo. Note gravelly soil on banks of channel. Looking east (downstream in channel).



9. Downstream hazard zone. Upper and Lower Valle Mines Dam out of picture to the right. Looking east.

10. Downstream hazard zone. Community of Valle Lake. Looking east. Upper Valle Mines Dam upstream (right) about 1.5 mi.

11. Valle Lake Dam approximately two miles below Upper Valle Mines Dam, within downstream hazard zone. Looking east.

APPENDIX B

Hydraulic/Hydrologic Data and Analyses

APPENDIX B
Hydraulic/Hydrologic Data and Analyses

B.1 Procedures

a. General. The hydraulic/hydrologic analyses were performed using the "HEC-1, Dam Safety Version (1 Apr 80)" computer program. The inflow hydrographs were developed for various precipitation events by applying them to a synthetic unit hydrograph. The inflow hydrographs were subsequently routed through the reservoir and appurtenant structures by the modified Puls reservoir routing option.

b. Precipitation events. The Probable Maximum Precipitation (PMP) and the 1 and 10 percent probability-of-occurrence events were used in the analyses. The total rainfall and corresponding distributions for the 1 and 10 percent probability events were provided by the St. Louis District, Corps of Engineers. The Probable Maximum Precipitation was determined from regional curves prepared by the US Weather Bureau (Hydrometeorological Report Number 33, 1956, reprinted 1967).

c. Unit hydrograph. The Soil Conservation Services (SCS) Dimensionless Unit Hydrograph method (National Engineering Handbook, Section 4, Hydrology, 1971) was used in the analysis. This method was selected because of its simplicity, applicability to drainage areas less than 10 mi^2, and its easy availability within the HEC-1 computer program.

The watershed lag time was computed using the SCS "curve number method" by an empirical relationship as follows:

$$L = \frac{\ell^{0.8}(s+1)^{0.7}}{1900\, Y^{0.5}} \qquad \text{(Equation 15-4)}$$

where: L = lag in hours
ℓ = hydraulic length of the watershed in feet
$s = \frac{1000}{CN} - 10$ where CN = hydrologic soil curve number
Y = average watershed land slope in percent

This empirical relationship accounts for the soil cover, average watershed slope and hydraulic length.

With the lag time thus computed, another empirical relationship is used to compute the time of concentration as follows:

$$T_C = \frac{L}{0.6} \qquad \text{(Equation 15-3)}$$

where: T_C = time of concentration in hours

L = lag in hours.

Subsequent to the computation of the time of concentration, the unit hydrograph duration was estimated utilizing the following relationship:

$$\Delta D = 0.133 T_c \qquad \text{(Equation 16-12)}$$

where: ΔD = duration of unit excess rainfall
T_c = time of concentration in hours.

The final interval was selected to provide at least three discharge ordinates prior to the peak discharge ordinate of the unit hydrograph. For this dam, a time interval of 10 minutes was used.

d. Infiltration losses. The infiltration losses were computed by the HEC-1 computer program internally using the SCS curve number method. The curve numbers were established taking into consideration the variables of: (a) antecedent moisture condition, (b) hydrologic soil group classification, (c) degree of development, (d) vegetative cover and (e) present land usage in the watershed.

Antecedent moisture condition III (AMC III) was used for the PMF events and AMC II was used for the 1 and 10 percent probability events, in accordance with the guidelines. The remaining variables are defined in the SCS procedure and judgements in their selection were made on the basis of visual field inspection.

e. Starting elevations. Reservoir starting water surface elevations for this dam were set as follows:

(1) 1 and 10 percent probability events and percent PMF storm not overtopping dam - high water mark, elev. 823.7

(2) Probable Maximum Storm - spillway crest elevation, elev. 827.5

f. Spillway Rating Curve. The basic weir equation was utilized to compute the spillway rating curve. The weir equation is as follows:

$$Q = CLH^{3/2}$$

where Q = discharge in cubic feet per second
L = effective length of spillway in feet
C = coefficient of discharge = 2.6
H = total head over spillway in feet

B.2 Pertinent Data

a. Drainage area. 0.24 mi^2

b. Storm duration. A unit hydrograph was developed by the SCS method option of HEC-1 program. The design storm of 48 hours duration was divided into 10 minute intervals in order to develop the inflow hydrograph.

c. Lag time. 0.53 hrs

d. Hydrologic soil group. C

e. SCS curve numbers.

1. For PMF- AMC III - Curve Number 87
2. For 1 and 10 percent probability-of-occurrence events AMC II - Curve Number 73

f. Storage. Elevation-area data were developed by planimetering areas at various elevation contours on the USGS Vineland, Missouri (1960) 7.5-minute quadrangle map. The data were entered on the $A and $E cards so that the HEC-1 program could compute storage volumes.

g. Outflow over dam crest. As the profile of the dam crest is irregular, flow over the crest was computed according to the "Flow Over Non-Level Dam Crest" supplement to the HEC-1 User's Manual. The crest length-elevation data and hydraulic constants were entered on the $D, $L, and $V cards.

h. Outflow capacity. The spillway rating curve was computed by the intrinsic formula within the HEC-1 program, with pertinent spillway data entered on the $$ cards.

i. Reservoir elevations. For the 50 and 100 percent of the PMF events, the starting reservoir elevation was 827.5 ft, the spillway crest elevation. For the 1 and 10 percent probability-of-occurrence events, and the maximum percent PMF not overtopping dam the starting reservoir elevation was 823.7 ft, the elevation of the high water line in the reservoir area.

B.3 Results

The results of the analyses as well as the input values to the HEC-1 program follow in this Appendix. Only the results summaries are included, not the intermediate output. Complete copies of the HEC-1 output are available in the project files.

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION        JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************

     1            A1      DAM NO. 30370 - UPPER VALLES MINE DAM, JEFFERSON COUNTY, MISSOURI.
     2            A2      WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 79CH009.
     3            A3      PROBABLE MAXIMUM FLOODS (PMF) ANALYSIS.
     4            B     288        0       10       -0       -0       -0       -0       -0       -0       -0
     5            B1      5
     6            J       1        2        1
     7            J1    .50     1.00
     8            K       0    QIN-1                                    1
     9            K1  UPPER VALLES MINE DAM INFLOW COMPUTATION, PMF RATIO FLOODS.
    10            M       1        2     0.24                         1.0
    11            P       0      26.      102      120      130      140
    12            T                                                    -1      -97                0.08
    13            W2               0.53
    14            X      -1     -.05        5
    15            K       1    DAM-1                                    1
    16            K1  UPPER VALLES MINE DAM FLOOD ROUTING, PMF RATIO FLOODS.
    17            Y                                 1        1
    18            Y1      1                                          -827.5
    19            SA     0.      6.8     11.5      13.     15.5     23.6
    20            SE   790.     820.    825.6    827.5     830.     840.
    21            SS  827.5       29      2.6      1.5
    22            SD  827.7      2.5      1.5
    23            SL     0.     450.     550.     665.     775.     935.
    24            SV  827.7     828.    828.5     829.    829.5     830.
    25            K      99
```

Note: Per response to Corps of Engineers Guidelines, the contour interval for computing reservoir storage has been recomputed. Correct input is shown on page B4a. Storage values and overtopping analysis were unaltered.

Input Data
Various PMF Events
Upper Valle Mines Dam
MO 30370

```
**********   ********************
HEC000 HYDR   SPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
.....
RUN  DATE: 12 DEC 80
     TIME: 09.44.29
```

DAM NO. 30370 - UPPER VALLES MINE DAM, JEFFERSON COUNTY, MISSOURI.
WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 79CH009.
PROBABLE MAXIMUM FLOODS (PMF) ANALYSIS.

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	-0	-0	-0	-0	-0	5	-0

JOPER	NWT	LROPT	TRACE
5	-0	-0	-0

SURFACE AREA=	0.	1.	3.	7.	12.	13.	16.	24.
CAPACITY=	0.	3.	21.	68.	119.	142.	178.	372.
ELEVATION=	790.	800.	810.	820.	826.	828.	830.	840.

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
827.5	29.0	2.6	1.5	-0.	-0.	-0.	-0.

DAM DATA

TOPEL	COOD	EXPD	DAMWID
827.7	2.5	1.5	-0.

PEAK OUTFLOW IS 822. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 1669. AT TIME 40.17 HOURS

Input Data
Various PMF Events
Upper Valle Mines Dam
MO 30370

B4a

```
FLOOD HYD  HAPH-PACKAGE-(HEC-1)
DAM SAFET  ERSION    JULY 1978
 EASY MODIFICATION  01 APR 80

RUN  DATE: 27 AUG 80
     TIME: 11.08.34

          DAM NO. 30370 - UPPER VALLES MINE DAM, JEFFERSON COUNTY, MISSOURI.
          WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 79CH009.
          PROBABLE MAXIMUM FLOODS (PMF) ANALYSIS.

                                JOB SPECIFICATION
      NO     NHR    NMIN    IDAY    IHR    IMIN   METRC    IPLT    IPRT   NSTAN
     288       0      10      -0      -0      -0      -0      -0      -0      -0
                          JOPER     NWT   LROPT   TRACE
                              5      -0      -0      -0

                     MULTI-PLAN ANALYSES TO BE PERFORMED
                     NPLAN= 1 NRTIO= 2 LRTIO= 1
          RTIOS=     .50   1.00

                          SUB-AREA RUNOFF COMPUTATION

     UPPER VALLES MINE DAM INFLOW COMPUTATION, PMF RATIO FLOODS.

                ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT  INAME  ISTAGE  IAUTO
               QIN-1       0      -0      -0      -0      -0      1      -0      -0

                              HYDROGRAPH DATA
     IHYDG    IUNG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
         1       2     .24      -0.     .24    1.00      -0.      -0      -0      -0

                                PRECIP DATA
          SPFE     PMS      R6     R12     R24     R48     R72     R96
            0.   20.00  102.00  120.00  130.00  140.00      0.      0.

                                LOSS DATA
     LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
        -0      -0.     -0.    1.00      -0.     -0.    1.00   -1.00  -87.00      -0.     .08
     CURVE NO =   -87.00  WETNESS =    -1.00  EFFECT CN =    87.00

                            UNIT HYDROGRAPH DATA
                          TC=   -0.     LAG=    .53

                              RECESSION DATA
                          STRTQ=   -1.00    QRCSN=    -.09    RTIOR= 9.00

     UNIT HYDROGRAPH 18 END OF PERIOD ORDINATES, TC=    -0.   HOURS, LAG=    .53  VOL= 1.00
        31.    104.    177.    187.    154.    100.     62.     41.     26.     17.
        11.      7.      4.      3.      2.      1.      1.      0.

                                END-OF-PERIOD FLOW
     0
   MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q       MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q
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Output Summary
Various PMF Events
Upper Valle Mines Dam
MO 30370

B5

1.	.30	3	.00	.00	.00	0.	1.02	.30	147	.03	.02	.00	16.
1.	.40	4	.00	.00	.00	0.	1.02	.40	148	.03	.02	.00	16.
1.01	.50	5	.00	.00	.00	0.	1.02	.50	149	.03	.03	.00	17.
1.01	1.00	6	.00	.00	.00	0.	1.02	1.00	150	.03	.03	.00	19.
1.01	1.10	7	.00	.00	.00	0.	1.02	1.10	151	.03	.03	.00	21.
1.01	1.20	8	.00	.00	.00	0.	1.02	1.20	152	.03	.03	.00	22.
1.01	1.30	9	.00	.00	.00	0.	1.02	1.30	153	.03	.03	.00	22.
1.01	1.40	10	.00	.00	.00	0.	1.02	1.40	154	.03	.03	.00	23.
1.01	1.50	11	.00	.00	.00	0.	1.02	1.50	155	.03	.03	.00	23.
1.01	2.00	12	.00	.00	.00	0.	1.02	2.00	156	.03	.03	.00	23.
1.01	2.10	13	.00	.00	.00	0.	1.02	2.10	157	.03	.03	.00	23.
1.01	2.20	14	.00	.00	.00	0.	1.02	2.20	158	.03	.03	.00	23.
1.01	2.30	15	.00	.00	.00	0.	1.02	2.30	159	.03	.03	.00	24.
1.01	2.40	16	.00	.00	.00	0.	1.02	2.40	160	.03	.03	.00	24.
1.01	2.50	17	.00	.00	.00	0.	1.02	2.50	161	.03	.03	.00	24.
1.01	3.00	18	.00	.00	.00	0.	1.02	3.00	162	.03	.03	.00	24.
1.01	3.10	19	.00	.00	.00	0.	1.02	3.10	163	.03	.03	.00	24.
1.01	3.20	20	.00	.00	.00	0.	1.02	3.20	164	.03	.03	.00	24.
1.01	3.30	21	.00	.00	.00	0.	1.02	3.30	165	.03	.03	.00	24.
1.01	3.40	22	.00	.00	.00	0.	1.02	3.40	166	.03	.03	.00	24.
1.01	3.50	23	.00	.00	.00	0.	1.02	3.50	167	.03	.03	.00	24.
1.01	4.00	24	.00	.00	.00	0.	1.02	4.00	168	.03	.03	.00	24.
1.01	4.10	25	.00	.00	.00	0.	1.02	4.10	169	.03	.03	.00	24.
1.01	4.20	26	.00	.00	.00	0.	1.02	4.20	170	.03	.03	.00	24.
1.01	4.30	27	.00	.00	.00	0.	1.02	4.30	171	.03	.03	.00	24.
1.01	4.40	28	.00	.00	.00	0.	1.02	4.40	172	.03	.03	.00	24.
1.01	4.50	29	.00	.00	.00	0.	1.02	4.50	173	.03	.03	.00	24.
1.01	5.00	30	.00	.00	.00	0.	1.02	5.00	174	.03	.03	.00	24.
1.01	5.10	31	.00	.00	.00	0.	1.02	5.10	175	.03	.03	.00	24.
1.01	5.20	32	.00	.00	.00	0.	1.02	5.20	176	.03	.03	.00	24.
1.01	5.30	33	.00	.00	.00	0.	1.02	5.30	177	.03	.03	.00	24.
1.01	5.40	34	.00	.00	.00	0.	1.02	5.40	178	.03	.03	.00	24.
1.01	5.50	35	.00	.00	.00	0.	1.02	5.50	179	.03	.03	.00	24.
1.01	6.00	36	.00	.00	.00	0.	1.02	6.00	180	.03	.03	.00	24.
1.01	6.10	37	.01	.00	.01	0.	1.02	6.10	181	.13	.12	.01	27.
1.01	6.20	38	.01	.00	.01	0.	1.02	6.20	182	.13	.12	.01	27.
1.01	6.30	39	.01	.00	.01	0.	1.02	6.30	183	.13	.12	.01	27.
1.01	6.40	40	.01	.00	.01	0.	1.02	6.40	184	.13	.12	.01	27.
1.01	6.50	41	.01	.00	.01	1.	1.02	6.50	185	.13	.12	.01	27.
1.01	7.00	42	.01	.00	.01	1.	1.02	7.00	186	.13	.12	.01	27.
1.01	7.10	43	.01	.00	.01	1.	1.02	7.10	187	.13	.12	.01	27.
1.01	7.20	44	.01	.00	.01	1.	1.02	7.20	188	.13	.12	.01	27.
1.01	7.30	45	.01	.00	.01	1.	1.02	7.30	189	.13	.12	.01	27.
1.01	7.40	46	.01	.00	.01	1.	1.02	7.40	190	.13	.12	.01	27.
1.01	7.50	47	.01	.00	.01	1.	1.02	7.50	191	.13	.12	.01	27.
1.01	8.00	48	.01	.00	.01	1.	1.02	8.00	192	.13	.12	.01	27.
1.01	8.10	49	.01	.00	.01	1.	1.02	8.10	193	.13	.12	.01	27.
1.01	8.20	50	.01	.00	.01	1.	1.02	8.20	194	.13	.12	.01	27.
1.01	8.30	51	.01	.00	.01	1.	1.02	8.30	195	.13	.12	.01	27.
1.01	8.40	52	.01	.00	.01	1.	1.02	8.40	196	.13	.12	.01	27.
1.01	8.50	53	.01	.00	.01	1.	1.02	8.50	197	.13	.12	.01	27.
1.01	9.00	54	.01	.00	.01	1.	1.02	9.00	198	.13	.12	.01	27.
1.01	9.10	55	.01	.00	.01	1.	1.02	9.10	199	.13	.12	.01	27.
1.01	9.20	56	.01	.00	.01	1.	1.02	9.20	200	.13	.13	.00	27.
1.01	9.30	57	.01	.00	.01	1.	1.02	9.30	201	.13	.13	.00	27.
1.01	9.40	58	.01	.00	.01	1.	1.02	9.40	202	.13	.13	.00	27.
1.01	9.50	59	.01	.00	.01	1.	1.02	9.50	203	.13	.13	.00	27.
1.01	10.00	60	.01	.00	.01	1.	1.02	10.00	204	.13	.13	.00	27.
1.01	10.10	61	.01	.00	.01	1.	1.02	10.10	205	.13	.13	.00	27.
1.01	10.20	62	.01	.00	.01	1.	1.02	10.20	206	.13	.13	.00	27.
1.01	10.30	63	.01	.00	.01	1.	1.02	10.30	207	.13	.13	.00	27.
1.01	10.40	64	.01	.00	.01	1.	1.02	10.40	208	.13	.13	.00	27.
1.01	10.50	65	.01	.00	.01	1.	1.02	10.50	209	.13	.13	.00	27.

1	11.40	70	.01	.00	.01	2.	1.02	11.40	214	.13	.13	.00	119.
1.01	11.50	71	.01	.00	.01	2.	1.02	11.50	215	.13	.13	.00	118.
1.01	12.00	72	.01	.00	.01	2.	1.02	12.00	216	.13	.13	.00	118.
1.01	12.10	73	.03	.01	.03	2.	1.02	12.10	217	.44	.43	.01	127.
1.01	12.20	74	.03	.01	.02	3.	1.02	12.20	218	.44	.43	.01	195.
1.01	12.30	75	.03	.01	.02	4.	1.02	12.30	219	.44	.43	.01	214.
1.01	12.40	76	.03	.01	.02	6.	1.02	12.40	220	.44	.43	.01	271.
1.01	12.50	77	.03	.01	.02	7.	1.02	12.50	221	.44	.44	.01	318.
1.01	13.00	78	.03	.01	.02	8.	1.02	13.00	222	.44	.44	.01	349.
1.01	13.10	79	.04	.02	.02	9.	1.02	13.10	223	.53	.52	.01	372.
1.01	13.20	80	.04	.02	.02	11.	1.02	13.20	224	.53	.52	.01	394.
1.01	13.30	81	.04	.02	.02	12.	1.02	13.30	225	.53	.52	.01	418.
1.01	13.40	82	.04	.02	.02	14.	1.02	13.40	226	.53	.52	.01	440.
1.01	13.50	83	.04	.02	.02	15.	1.02	13.50	227	.53	.53	.01	457.
1.01	14.00	84	.04	.02	.02	16.	1.02	14.00	228	.53	.53	.00	468.
1.01	14.10	85	.05	.03	.02	17.	1.02	14.10	229	.66	.66	.01	479.
1.01	14.20	86	.05	.03	.02	19.	1.02	14.20	230	.66	.66	.01	498.
1.01	14.30	87	.05	.03	.02	21.	1.02	14.30	231	.66	.66	.00	524.
1.01	14.40	88	.05	.03	.02	23.	1.02	14.40	232	.66	.66	.00	551.
1.01	14.50	89	.05	.03	.02	24.	1.02	14.50	233	.66	.66	.00	573.
1.01	15.00	90	.05	.03	.02	26.	1.02	15.00	234	.66	.66	.00	587.
1.01	15.10	91	.05	.03	.02	27.	1.02	15.10	235	.60	.60	.00	598.
1.01	15.20	92	.08	.05	.03	28.	1.02	15.20	236	1.01	1.00	.00	607.
1.01	15.30	93	.14	.10	.04	32.	1.02	15.30	237	1.81	1.81	.01	667.
1.01	15.40	94	.35	.26	.09	46.	1.02	15.40	238	4.53	4.52	.02	894.
1.01	15.50	95	.10	.08	.02	69.	1.02	15.50	239	1.31	1.31	.00	1252.
1.01	16.00	96	.06	.05	.01	90.	1.02	16.00	240	.81	.80	.00	1620.
1.01	16.10	97	.05	.04	.01	94.	1.02	16.10	241	.62	.62	.00	1690.
1.01	16.20	98	.05	.04	.01	85.	1.02	16.20	242	.62	.62	.00	1480.
1.01	16.30	99	.05	.04	.01	69.	1.02	16.30	243	.62	.62	.00	1156.
1.01	16.40	100	.05	.04	.01	57.	1.02	16.40	244	.62	.62	.00	933.
1.01	16.50	101	.05	.04	.01	50.	1.02	16.50	245	.62	.62	.00	833.
1.01	17.00	102	.05	.04	.01	45.	1.02	17.00	246	.62	.62	.00	759.
1.01	17.10	103	.04	.03	.01	42.	1.02	17.10	247	.49	.49	.00	698.
1.01	17.20	104	.04	.03	.01	39.	1.02	17.20	248	.49	.49	.00	624.
1.01	17.30	105	.04	.03	.01	36.	1.02	17.30	249	.49	.49	.00	576.
1.01	17.40	106	.04	.03	.01	34.	1.02	17.40	250	.49	.49	.00	536.
1.01	17.50	107	.04	.03	.01	32.	1.02	17.50	251	.49	.49	.00	503.
1.01	18.00	108	.04	.03	.01	31.	1.02	18.00	252	.49	.49	.00	488.
1.01	18.10	109	.00	.00	.00	30.	1.02	18.10	253	.04	.04	.00	466.
1.01	18.20	110	.00	.00	.00	26.	1.02	18.20	254	.04	.04	.00	405.
1.01	18.30	111	.00	.00	.00	21.	1.02	18.30	255	.04	.04	.00	326.
1.01	18.40	112	.00	.00	.00	19.	1.02	18.40	256	.04	.04	.00	294.
1.01	18.50	113	.00	.00	.00	11.	1.02	18.50	257	.04	.04	.00	164.
1.01	19.00	114	.00	.00	.00	8.	1.02	19.00	258	.04	.04	.00	119.
1.01	19.10	115	.00	.00	.00	6.	1.02	19.10	259	.04	.04	.00	91.
1.01	19.20	116	.00	.00	.00	5.	1.02	19.20	260	.04	.04	.00	76.
1.01	19.30	117	.00	.00	.00	4.	1.02	19.30	261	.04	.04	.00	69.
1.01	19.40	118	.00	.00	.00	3.	1.02	19.40	262	.04	.04	.00	59.
1.01	19.50	119	.00	.00	.00	3.	1.02	19.50	263	.04	.04	.00	48.
1.01	20.00	120	.00	.00	.00	3.	1.02	20.00	264	.04	.04	.00	45.
1.01	20.10	121	.00	.00	.00	3.	1.02	20.10	265	.04	.04	.00	43.
1.01	20.20	122	.00	.00	.00	3.	1.02	20.20	266	.04	.04	.00	42.
1.01	20.30	123	.00	.00	.00	3.	1.02	20.30	267	.04	.04	.00	41.
1.01	20.40	124	.00	.00	.00	3.	1.02	20.40	268	.04	.04	.00	41.
1.01	20.50	125	.00	.00	.00	3.	1.02	20.50	269	.04	.04	.00	40.
1.01	21.00	126	.00	.00	.00	3.	1.02	21.00	270	.04	.04	.00	40.
1.01	21.10	127	.00	.00	.00	3.	1.02	21.10	271	.04	.04	.00	40.
1.01	21.20	128	.00	.00	.00	3.	1.02	21.20	272	.04	.04	.00	40.
1.01	21.30	129	.00	.00	.00	3.	1.02	21.30	273	.04	.04	.00	40.
1.01	21.40	130	.00	.00	.00	3.	1.02	21.40	274	.04	.04	.00	40.
1.01	21.50	131	.00	.00	.00	3.	1.02	21.50	275	.04	.04	.00	40.

Output Summary
Various PMF Events
Upper Valle Mines Dam
MD 30370

1	22.20	134	.00	.00	.00	3.	1.02	22.20	278	.04	.04	.00	4C.
1	22.30	135	.00	.00	.00	3.	1.02	22.30	279	.04	.04	.00	4C.
1.01	22.40	136	.00	.00	.00	3.	1.02	22.40	280	.04	.04	.00	4C.
1.01	22.50	137	.00	.00	.00	3.	1.02	22.50	281	.04	.04	.00	4C.
1.01	23.00	138	.00	.00	.00	3.	1.02	23.00	282	.04	.04	.00	4C.
1.01	23.10	139	.00	.00	.00	3.	1.02	23.10	283	.04	.04	.00	4C.
1.01	23.20	140	.00	.00	.00	3.	1.02	23.20	284	.04	.04	.00	4C.
1.01	23.30	141	.00	.00	.00	3.	1.02	23.30	285	.04	.04	.00	4C.
1.01	23.40	142	.00	.00	.00	3.	1.02	23.40	286	.04	.04	.00	4C.
1.01	23.50	143	.00	.00	.00	3.	1.02	23.50	287	.04	.04	.00	4C.
1.02	0.	144	.00	.00	.00	3.	1.03	0.	288	.04	.04	.00	4C.
									SUM	36.40	34.80	1.60	32196C.
										925.11	884.11	41.11	911.921

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1670.	662.	214.	112.	32167.
CMS	47.	19.	6.	3.	911.
INCHES		25.67	33.15	34.63	34.63
MM		652.09	842.06	879.67	879.67
AC-FT		326.	424.	443.	443.
THOUS CU M		405.	523.	547.	547.

HYDROGRAPH AT STA QIN-1 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	3.	4.	4.	5.	5.
6.	7.	7.	8.	9.	9.	10.	11.	12.	13.
13.	14.	16.	23.	39.	49.	47.	42.	35.	29.
25.	22.	21.	19.	18.	17.	16.	16.	15.	13.
10.	9.	5.	4.	3.	2.	2.	2.	2.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	3.	5.	7.	9.	10.
10.	11.	11.	11.	11.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
14.	18.	27.	39.	43.	48.	51.	53.	54.	55.
56.	56.	57.	57.	57.	57.	57.	58.	58.	58.
58.	58.	58.	58.	58.	58.	58.	58.	58.	59.
59.	59.	59.	59.	59.	59.	64.	80.	107.	136.
159.	175.	186.	197.	209.	220.	228.	234.	240.	249.
262.	276.	286.	294.	297.	303.	333.	449.	646.	815.
839.	740.	598.	497.	416.	370.	338.	312.	288.	268.
253.	243.	230.	202.	160.	117.	82.	60.	45.	38.
32.	28.	24.	23.	22.	21.	21.	20.	20.	20.
20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
20.	20.	20.	20.	20.	20.	20.	20.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	839.	331.	107.	56.	16083.
CMS	24.	9.	3.	2.	455.
INCHES		12.84	16.98	17.32	17.32
MM		326.05	421.03	439.84	439.84
AC-FT		164.	212.	222.	222.

Output Summary
Various PMF Events
Upper Valle Mines Dam
MO 30370

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4
				.10	.11	.12	.13
HYDROGRAPH AT	GIN-1	.24	1	147.	184.	200.	217.
		(.62)	(	4.73)(	5.20)(	5.67)(	6.15)(
ROUTED TO	DAM-1	.24	1	1.	7.	34.	54.
		(.62)	(	.01)(	.20)(	.96)(	1.67)(

Output Summary
Various PMF Events
Upper Valle Mines Dam
MO 30370.

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	823.70	827.50	827.70
STORAGE	98.	147.	145.
OUTFLOW	0.	0.	7.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	827.54	0.	142.	1.	0.	48.00	0.
.11	827.71	.01	145.	7.	1.50	43.50	0.
.12	827.86	.16	147.	34.	5.50	42.50	0.
.13	827.92	.22	147.	59.	7.00	42.17	0.

Output Summary
Various PMF Events
Upper Valle Mines Dam
MO 30370

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2
				.90	1.00
HYDROGRAPH AT	GIN-1	.24	1	839.	1870.
		(.621	(	23.64)(	47.29)(
ROUTED TO	DAM-1	.24	1	822.	1869.
		(.621	(	23.27)(	47.26)(

Output Summary
Various PMF Events
Upper Valle Mines Dam
MO 30370

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	927.50	927.50	927.70
STORAGE	142.	142.	145.
OUTFLOW	0.	0.	7.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	820.49	.79	155.	822.	26.00	40.17	0.
1.00	820.85	1.15	160.	1669.	29.67	40.17	0.

Output Summary
Various PMF Events
Upper Valle Mines Dam
MO 30370

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